

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Jurina WESSELS et al.

Filed: Filed Concurrently Herewith

Title of Invention: TUNED MULTIFUNCTIONAL LINKER MOLECULES
FOR ELECTRONIC CHARGE TRANSPORT
THROUGH ORGANIC-INORGANIC COMPOSITE
STRUCTURES AND USE THEREOF


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PRELIMINARY AMENDMENT

Assistant Commissioner for Patents
Box Patent Application (35 U.S.C. 111)
Washington, D.C. 20231

Sir:

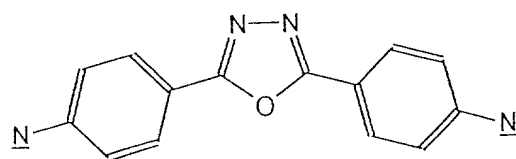
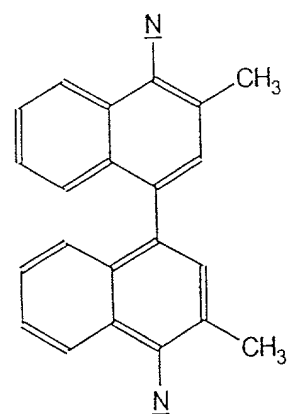
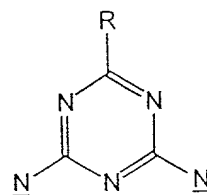
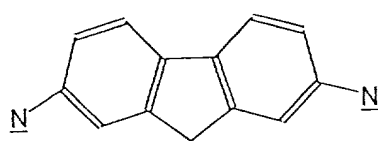
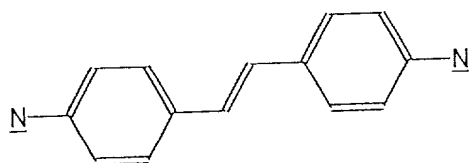
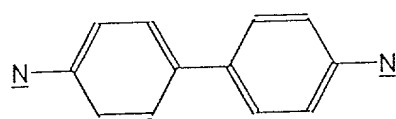
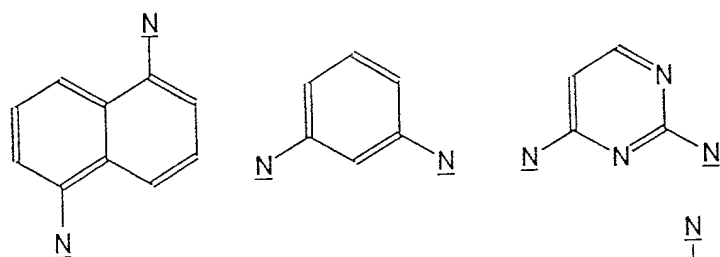
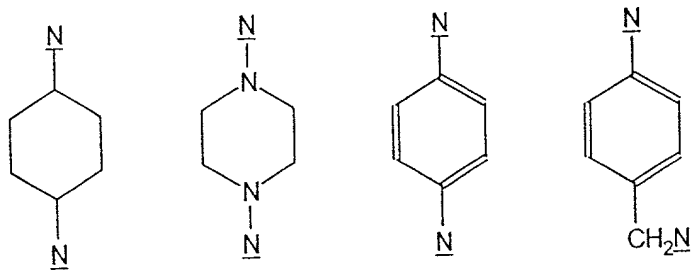
Before the issuance of the first Office Action, please amend the above-identified application as follows:

IN THE CLAIMS:

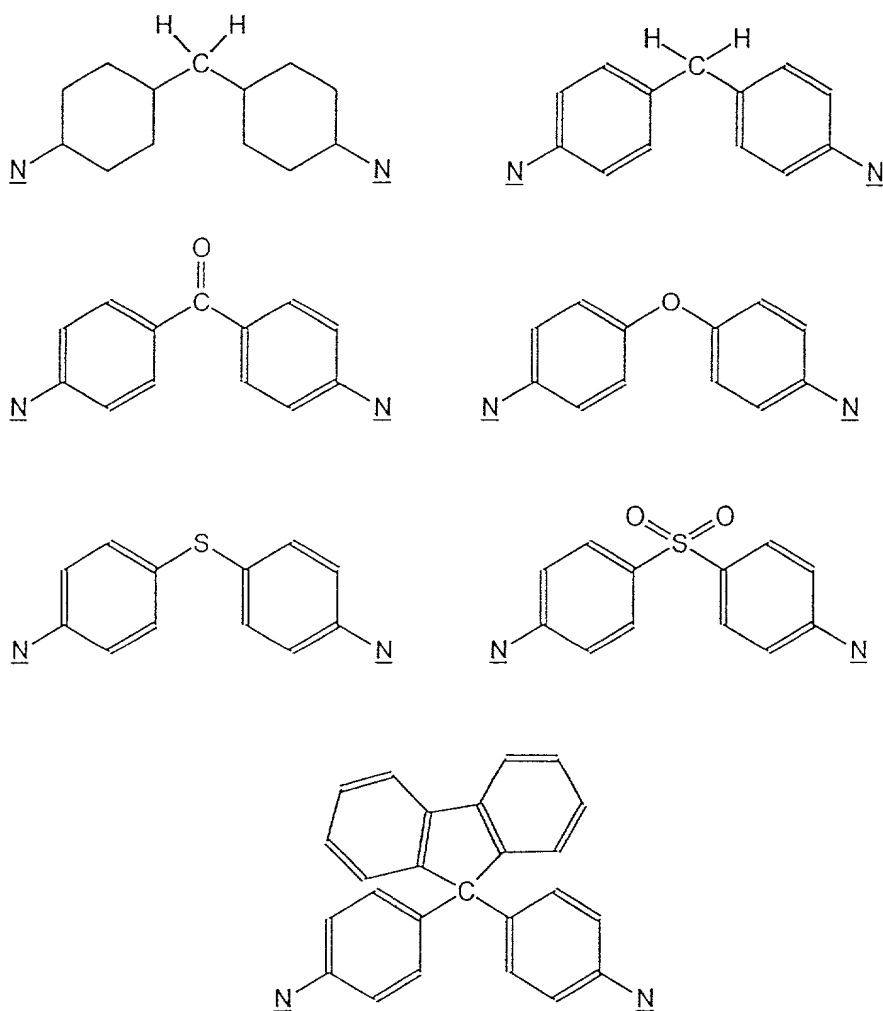
Please amend claims 3, 4, 6-9, 14, 16 and 17 as follows:

3. (Amended) A multifunctional linker molecule according to claim 1, characterized in that it exhibits a length between about 8 Å and about 30 Å.

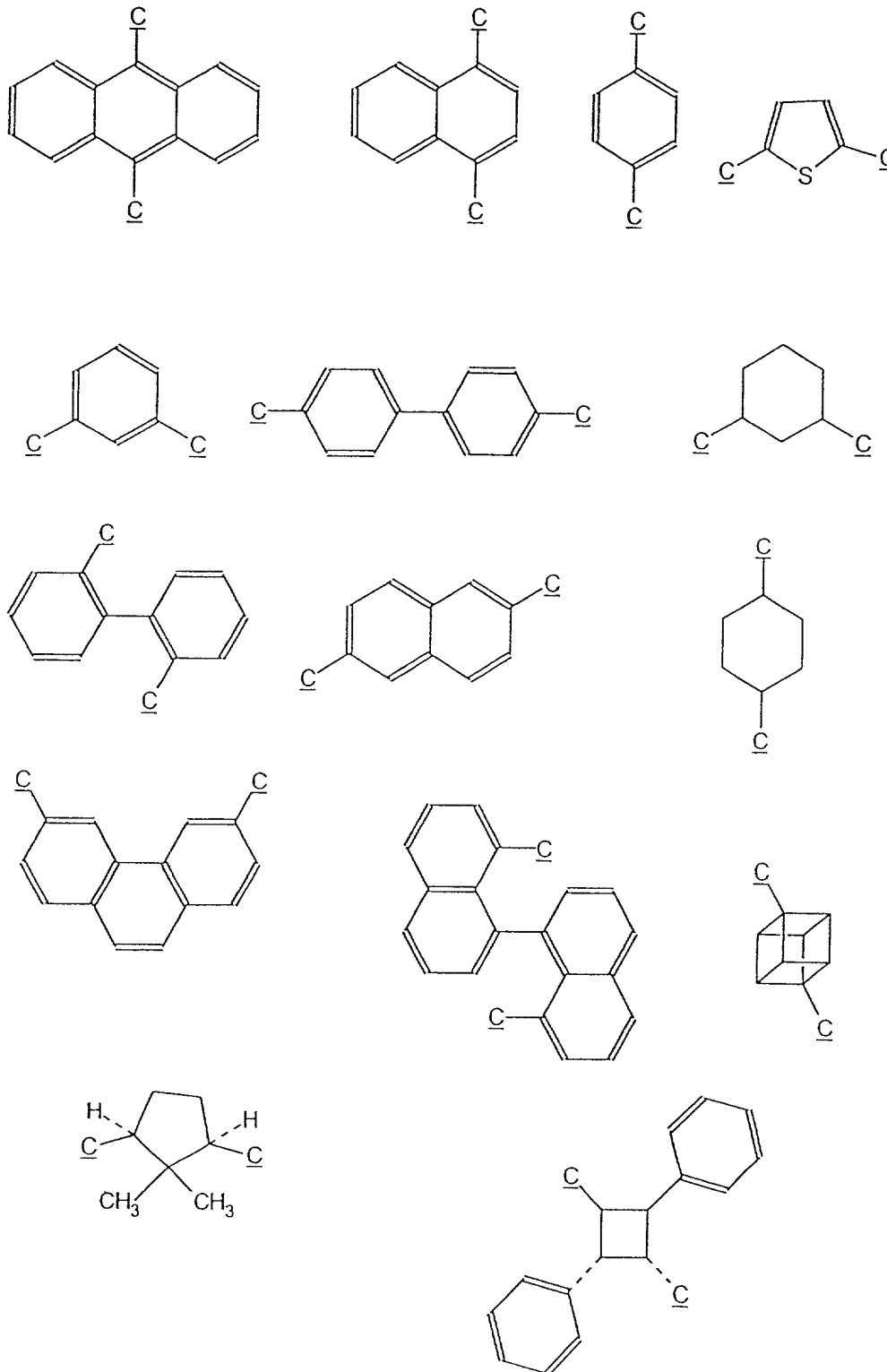
4. (Amended) A multifunctional linker molecule according to claim 1, characterized in that X comprises a structure having a hydrocarbon skeleton with two identical or different substituents that are used for connecting to and/or forming of the molecular groups FUNC₁ and FUNC₂.
6. (Amended) A multifunctional linker molecule according to claim 4, characterized in that the substituents of X are directed at an angle α relative to one another such that $90^\circ < \alpha < 270^\circ$.
7. (Amended) A multifunctional linker molecule according to claim 4, characterized in that X comprises a conjugated system, an aromatic π -system and/or contains heteroatoms, like N, O or S, and/or contains at least one electron donating substituent, like CH₃, O⁻, COO⁻, N(CH₃)₂ or NH₂, and/or electron accepting substituent, like CN, COCH₃, CONH₂, CO₂CH₃, N(CH₃)₃⁺, NO₂, F, Cl, Br, I, OCF₃, or SO₂NH₂.
8. (Amended) A multifunctional linker molecule according to claim 4, characterized in that X is selected from the group comprising
 - a) linear or branched structures comprising alkanes, alkenes, alkynes and combinations thereof comprising 3-12 carbon atoms and exhibiting at two ends substituents of the group consisting of amines, carboxylic acids, sulfonic acids and phosphonic acids;
 - b) structures having the general formula



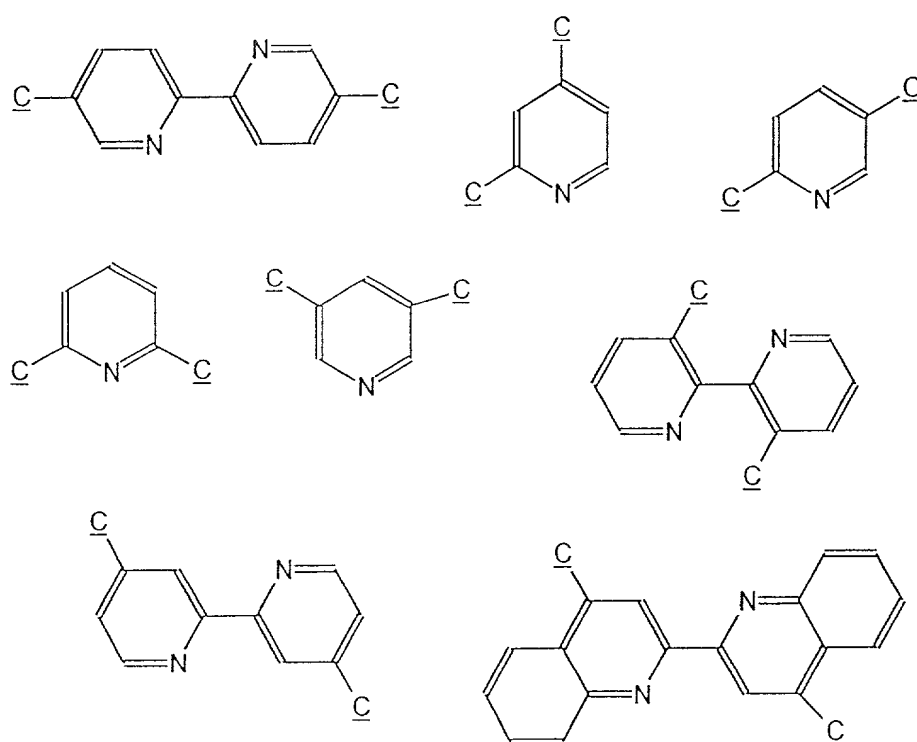
and derivatives thereof containing heteroatoms, like N, S, and/or O, or electron donating or accepting substituents; R can be methyl, phenyl or alkoxy and wherein FUNC_1 and FUNC_2 are attached via the N-atoms of the two amine substituents indicated by N; structures having the general formula



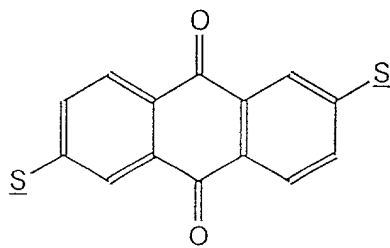
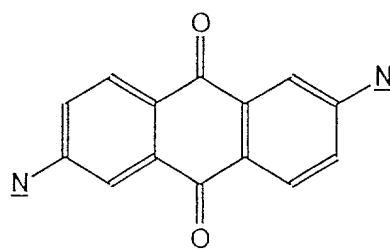
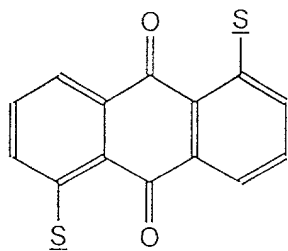
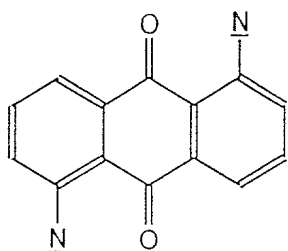
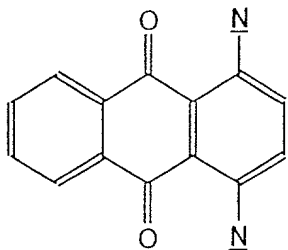
and derivatives thereof containing electron donating or accepting substituents wherein FUNC_1 and FUNC_2 are attached via the N-atoms of the amine substituents indicated by N; structures having the general formula



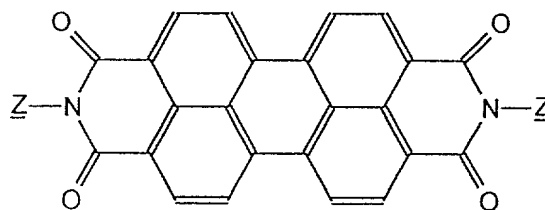
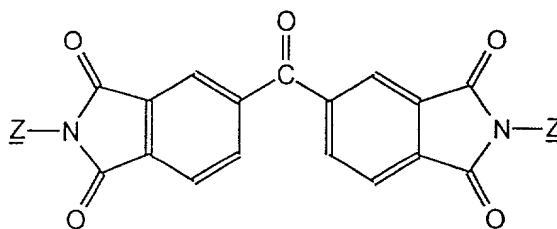
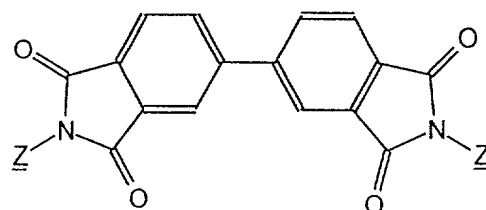
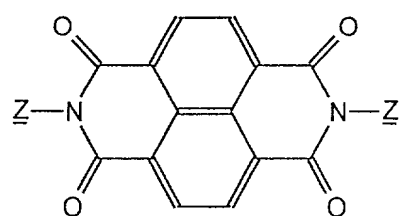
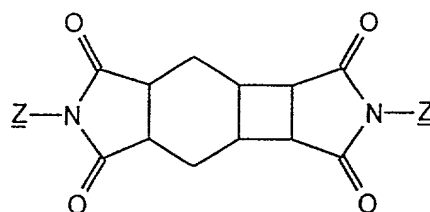
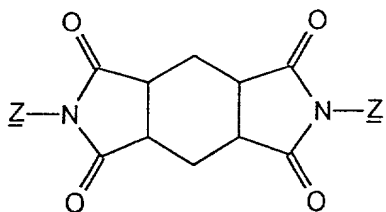
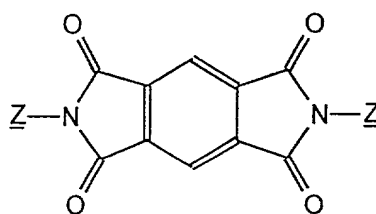
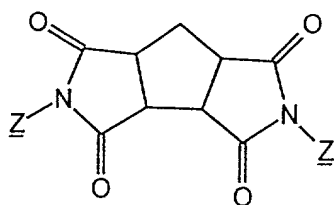
and derivatives thereof containing heteroatoms, like N, S, and/or O, or electron donating or accepting substituents; and wherein FUNC_1 and FUNC_2 are attached via the carbon atoms of the two carboxylic acid substituents indicated by C; structures having the general formula



wherein FUNC_1 and FUNC_2 are attached via the carbon atoms of the two carboxylic acid substituents indicated by C; structures having the general formula



and derivatives thereof containing electron donating or accepting substituents wherein FUNC_1 and FUNC_2 are attached via the N- or S-atoms of the two amine or sulfonic acid substituents indicated by N and S; structures having the general formula



in which \underline{Z} represents amine ($\underline{Z}=\underline{N}$) or a carboxymethyl ($\underline{Z}=\underline{CH(R)C}$) residue, wherein R is an amino acid side chain and FUNC_1 and FUNC_2 are attached via \underline{Z} ; and

c) electron donors like hydroquinones and electron acceptors, like quinones and diimides carrying to substituents of the group consisting of amines, carboxylic acids, sulfonic acids and phosphonic acids.

9. (Amended) A multifunctional linker molecule according to claim 1, characterized in that FUNC_1 and FUNC_2 independently of each other are connected to X via N, C, S, or P, and are selected from the group comprising

$-\text{NH}$, $-\text{NHCO}$, $-\text{NHCONH}$, $-\text{NHCSNH}$, $-\text{NHCONHNH}$, $-\text{NHCSNHNH}$, $-\text{NHCONHNHCO}$, and $-\text{NHCONHNHCO}$ in case of a connection via N;

$-\text{CONH}$, $-\text{CONHNH}$, and $-\text{CONHNHCO}$ in case of a connection via C;

$-\text{SO}_2\text{NH}$, $-\text{SO}_2\text{NHNH}$, and $-\text{SO}_2\text{NHNHCO}$ in case of a connection via S; and

$-\text{PO}_2\text{NH}$, $-\text{PO}_2\text{NHNH}$, and $-\text{PO}_2\text{NHNHCO}$ in case of a connection via P.

10. (Amended) A multifunctional linker molecule according to claim 1, characterized in that CON_1 and CON_2 connected to FUNC_1 and FUNC_2 via NH or CO, independently of each other are selected from the groups comprising

$-(\text{CHR})_n\text{COOH}$; $-(\text{CHR})_n\text{NC}$; $-(\text{CHR})_n\text{NH}_2$; $-(\text{CHR})_n\text{NHCS}_2\text{H}$; $-(\text{CHR})_n\text{OPO}_3\text{H}_2$; -

$(\text{CHR})_n\text{OSO}_3\text{H}$; $-(\text{CHR})_n\text{PO}_3\text{H}_2$; $-(\text{CHR})_n\text{SH}$; $-(\text{CHR})_n\text{SO}_3\text{H}$; $-\text{CSOH}$; and $-\text{CS}_2\text{H}$ in case of a connection via NH; and

$-(\text{CHR})_n\text{COOH}$; $-(\text{CHR})_n\text{NC}$; $-(\text{CHR})_n\text{NH}_2$; $-(\text{CHR})_n\text{NHCS}_2\text{H}$; $-(\text{CHR})_n\text{OPO}_3\text{H}_2$; -

$(\text{CHR})_n\text{OSO}_3\text{H}$; $-(\text{CHR})_n\text{PO}_3\text{H}_2$; $-(\text{CHR})_n\text{SH}$; and $-(\text{CHR})_n\text{SO}_3\text{H}$ in case of a connection via CO;

and

where R is H, CH_2OH , or CH_3 and n is 1 or 2, and iconic forms thereof.

14. (Amended) 1-, 2-, or 3-dimensional assembly of nanostructured units comprising a multifunctional linker according to claim 1, wherein the conductivity of the assembly is determined by the structure of the multifunctional linker.

16. (Amended) Assembly according to claim 14 in the form of a thin film of interconnected nanostructured units.

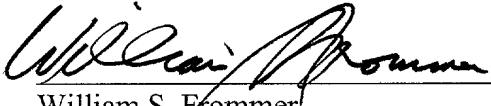
17. (Amended) Use of an assembly according to claim 14 as self-assembled electronic circuit elements, electrodes, and metal coatings.

REMARKS

Claims 1-17 remain in the application. Claims 3, 4, 6-9, 14, 16 and 17 have been amended to eliminate multiple dependencies. Attached hereto is a marked up version of the changes made to claims 3, 4, 6-9, 14, 16 and 17 by the current amendment. The attached page is captioned **"Version with markings to show changes made."** The filing fee has been calculated based upon these amendments to the claims.

Respectfully submitted,

FROMMER LAWRENCE & HAUG LLP
Attorneys for Applicants

By: 
William S. Frommer
Reg. No. 25,506
Tel. (212) 588-0800

VERSION WITH MARKINGS TO SHOW CHANGES MADE**In the claims:**

3. (Amended) A multifunctional linker molecule according to claim 1 ~~or~~ 2, characterized in that it exhibits a length between about 8 Å and about 30 Å.

4. (Amended) A multifunctional linker molecule according to claim 1 ~~any of claims 1 to 3~~, characterized in that X comprises a structure having a hydrocarbon skeleton with two identical or different substituents that are used for connecting to and/or forming of the molecular groups FUNC₁ and FUNC₂.

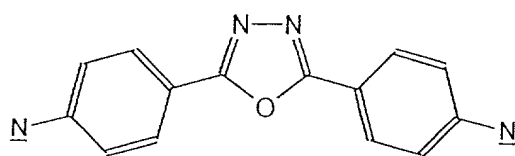
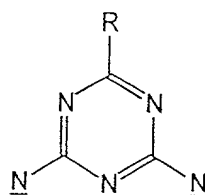
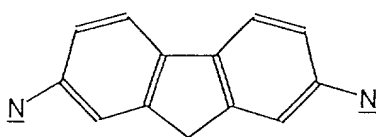
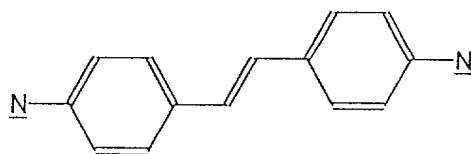
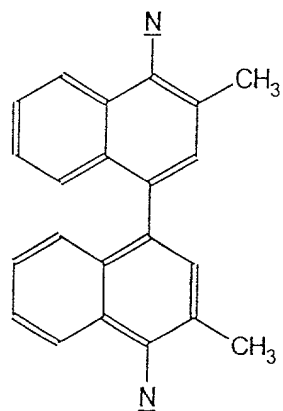
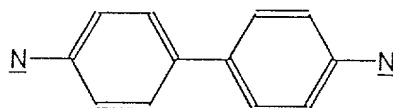
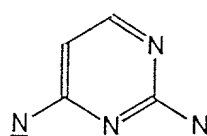
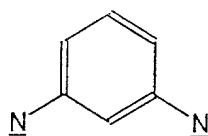
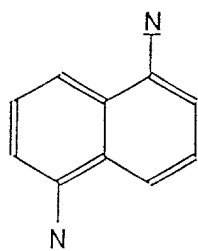
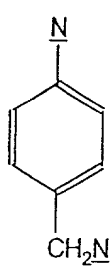
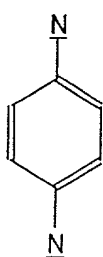
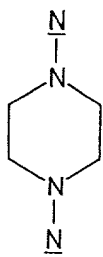
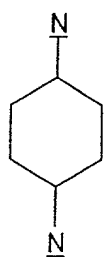
6. (Amended) A multifunctional linker molecule according to claim 4 ~~or~~ 5, characterized in that the substituents of X are directed at an angle α relative to one another such that $90^\circ < \alpha < 270^\circ$.

7. (Amended) A multifunctional linker molecule according to claim 4 ~~any of claims 4 to 6~~, characterized in that X comprises a conjugated system, an aromatic π -system and/or contains heteroatoms, like N, O or S, and/or contains at least one electron donating substituent, like CH₃, O⁻, COO⁻, N(CH₃)₂ or NH₂, and/or electron accepting substituent, like CN, COCH₃, CONH₂, CO₂CH₃, N(CH₃)₃⁺, NO₂, F, Cl, Br, I, OCF₃, or SO₂NH₂.

8. (Amended) A multifunctional linker molecule according to claim 4 ~~any of claims 4 to 7~~, characterized in that X is selected from the group comprising

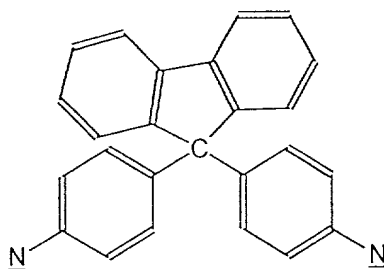
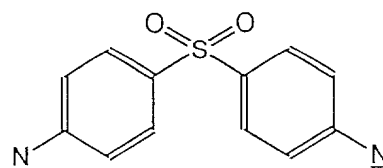
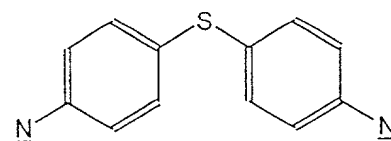
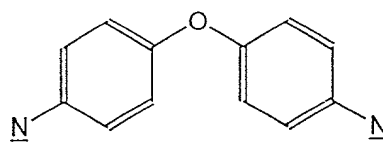
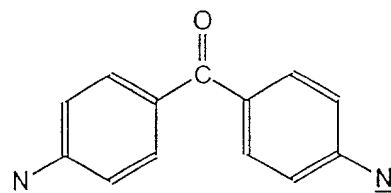
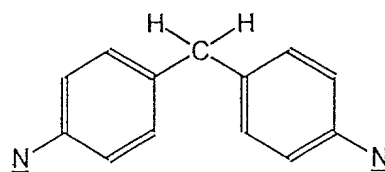
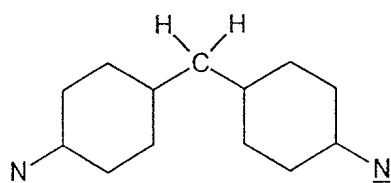
a) linear or branched structures comprising alkanes, alkenes, alkynes and combinations thereof comprising 3-12 carbon atoms and exhibiting at two ends substituents of the group consisting of amines, carboxylic acids, sulfonic acids and phosphonic acids according to claim 5;

b) structures having the general formula

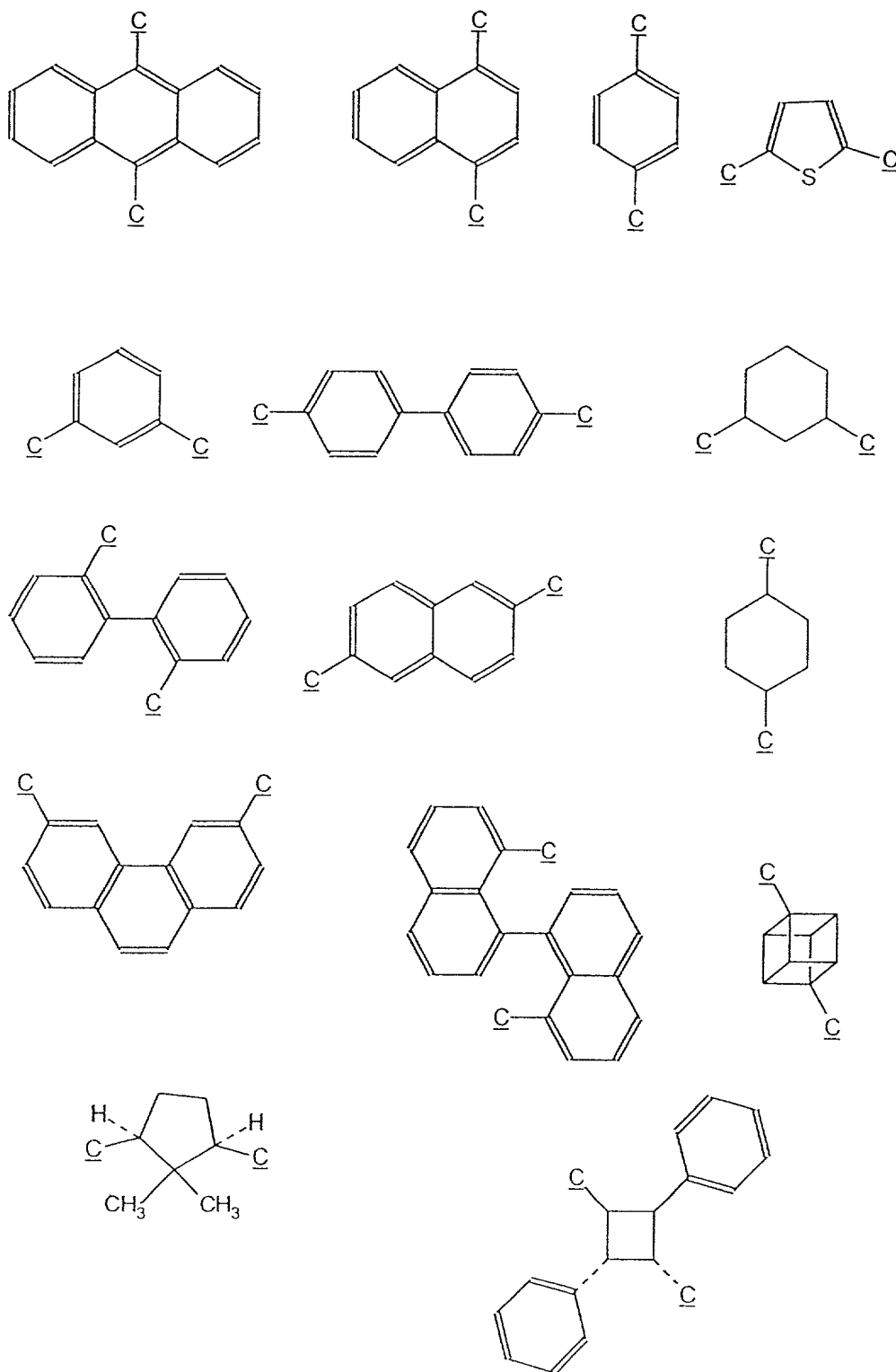


Chemical structure of 1,3-diazabenzene

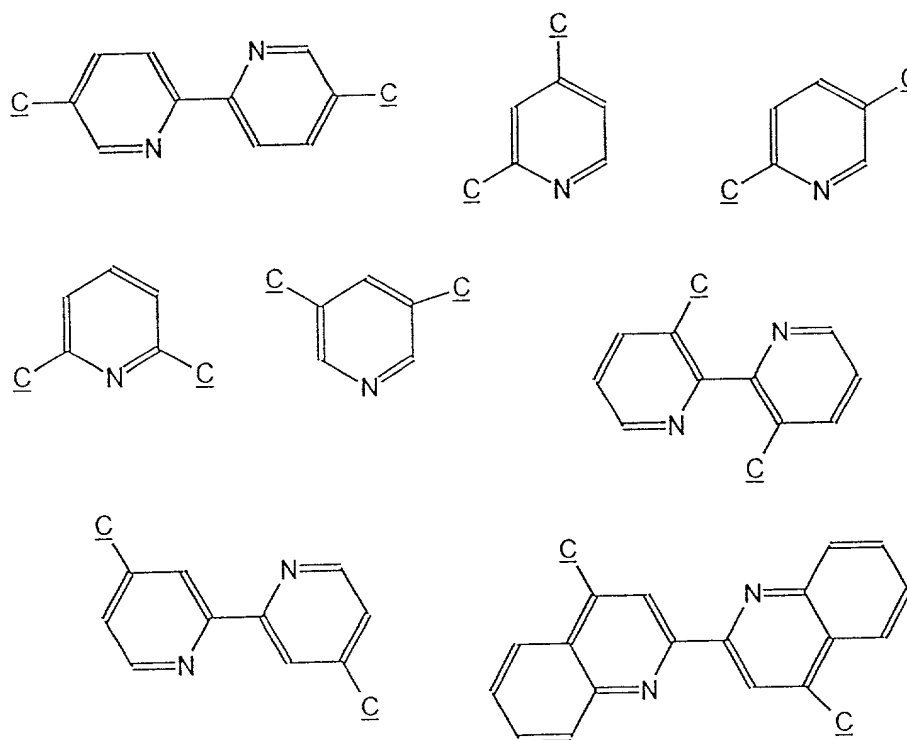
and derivatives thereof containing heteroatoms, like N, S, and/or O, or electron donating or accepting substituents; R can be methyl, phenyl or alkoxyl and wherein FUNC_1 and FUNC_2 are attached via the N-atoms of the two amine substituents indicated by N; structures having the general formula



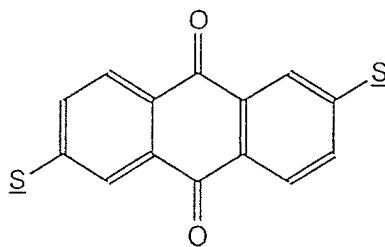
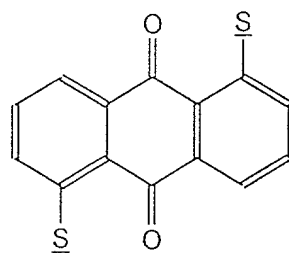
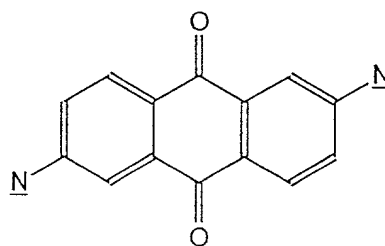
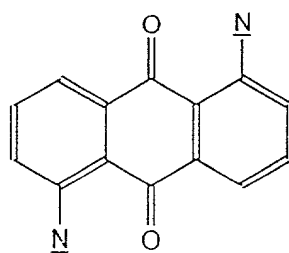
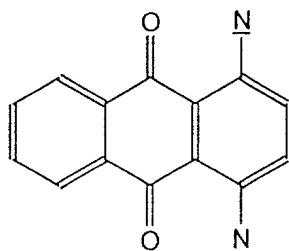
and derivatives thereof containing electron donating or accepting substituents wherein FUNC_1 and FUNC_2 are attached via the N-atoms of the amine substituents indicated by N; structures having the general formula



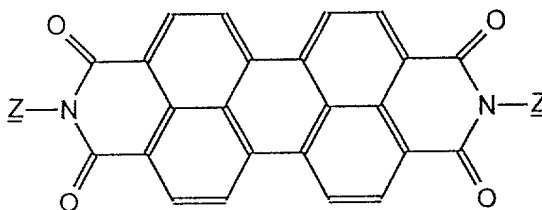
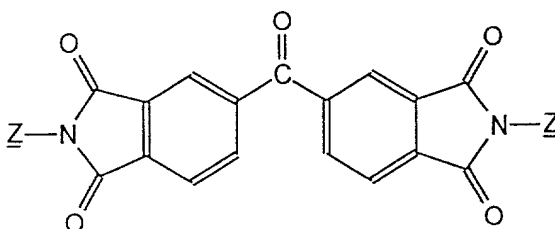
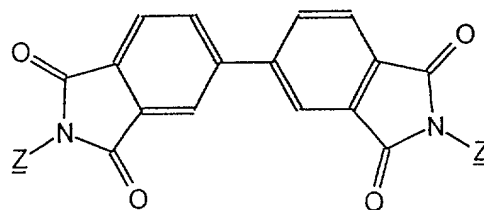
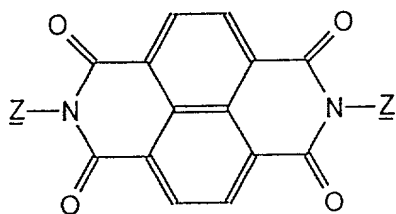
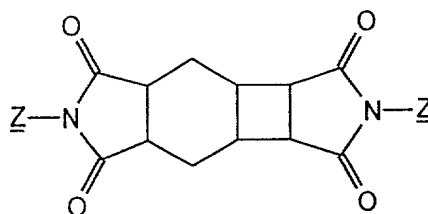
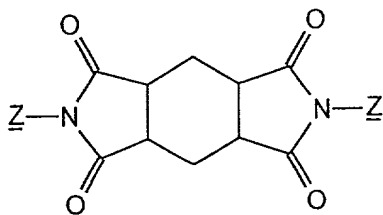
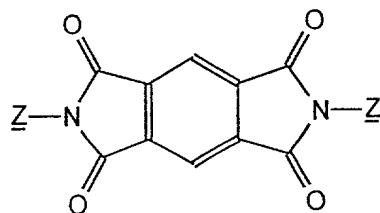
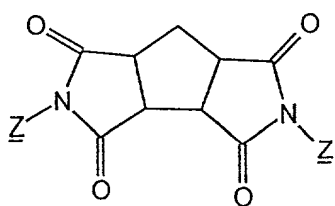
and derivatives thereof containing heteroatoms, like N, S, and/or O, or electron donating or accepting substituents; and wherein FUNC_1 and FUNC_2 are attached via the carbon atoms of the two carboxylic acid substituents indicated by C; structures having the general formula



wherein FUNC_1 and FUNC_2 are attached via the carbon atoms of the two carboxylic acid substituents indicated by C; structures having the general formula



and derivatives thereof containing electron donating or accepting substituents wherein FUNC_1 and FUNC_2 are attached via the N- or S-atoms of the two amine or sulfonic acid substituents indicated by N and S; structures having the general formula



amino acid side chain and FUNC_1 and FUNC_2 are attached via $\underline{\text{Z}}$; and

c) electron donors like hydroquinones and electron acceptors, like quinones and diimides

carrying to substituents of the groups consisting of amines, carboxylic acids, sulfonic acids and phosphonic acids according to claim 5.

9. (Amended) A multifunctional linker molecule according to claim 1 ~~any of claims 1 to 8~~, characterized in that FUNC_1 and FUNC_2 independently of each other are connected to X via N, C, S, or P, and are selected from the group comprising

-NH, -NHCO, -NHCONH, -NHCSNH, -NHCONHNH, -NHCSNHNH, -NHCONHNHCO, and -NHCONHNHCO in case of a connection via N;

-CONH, -CONHNH, and -CONHNHCO in case of a connection via C;

-SO₂NH, -SO₂NHNH, and -SO₂NHNHCO in case of a connection via S; and

-PO₂NH, -PO₂NHNH, and -PO₂NHNHCO in case of a connection via P.

10. (Amended) A multifunctional linker molecule according to claim 1 ~~any of claims 1 to 9~~, characterized in that CON_1 and CON_2 connected to FUNC_1 and FUNC_2 via NH or CO, independently of each other are selected from the groups comprising

-(CHR)_nCOOH; -(CHR)_nNC; -(CHR)_nNH₂; -(CHR)_nNHCS₂H; -(CHR)_nOPO₃H₂; -

(CHR)_nOSO₃H; -(CHR)_nPO₃H₂; -(CHR)_nSH; -(CHR)_nSO₃H; -CSOH; and -CS₂H in case of a connection via NH; and

-(CHR)_nCOOH; -(CHR)_nNC; -(CHR)_nNH₂; -(CHR)_nNHCS₂H; -(CHR)_nOPO₃H₂; -

(CHR)_nOSO₃H; -(CHR)_nPO₃H₂; -(CHR)_nSH; and -(CHR)_nSO₃H in case of a connection via CO;

and

where R is H, CH₂OH, or CH₃ and n is 1 or 2, and iconic forms thereof.

14. (Amended) 1-, 2-, or 3-dimensional assembly of nanostructured units comprising a multifunctional linker according to claim 1 ~~any of claims 1 to 13~~, wherein the conductivity of the assembly is determined by the structure of the multifunctional linker.

16. (Amended) Assembly according to claim 14 ~~or 15~~ in the form of a thin film of interconnected nanostructured units.

17. (Amended) Use of an assembly according to claim 14 ~~any of claims 14 to 16~~ as self-assembled electronic circuit elements, electrodes, and metal coatings.

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